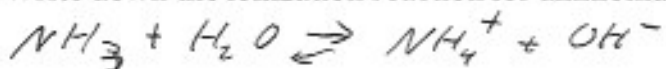


1. The molar conductivity Λ at 18° C of a 0.0100M aqueous solution of ammonia is 9.6 S cm²/mol. Given Λ_0 values (in S cm²/mol) of 144.0 (OH⁻), 65.6 (Cl⁻) and 129.8 (NH₄Cl),

a) Write down the ionization reaction for ammonia solution



b) What is Λ_0 for aqueous ammonia solution?

$$\Lambda_0 = \Lambda_0(\text{NH}_4\text{Cl}) - \Lambda_0(\text{Cl}^-) + \Lambda_0(\text{OH}^-) = 208.2 \frac{\text{S cm}^2}{\text{mol}}$$

c) What is the concentration of OH⁻ in solution?

$$\alpha = \frac{\Lambda}{\Lambda_0} = \frac{9.6}{208.2} = 0.046, [\text{OH}^-] = c \cdot \alpha = 0.01 \cdot 0.046 = 4.6 \cdot 10^{-4} \text{ M}$$

d) What is the equilibrium constant for the reaction of a)

$$K_{eq} = \frac{[\text{NH}_4^+][\text{OH}^-]}{[\text{NH}_3]} = \frac{(c\alpha)^2}{c(1-\alpha)} = \frac{c\alpha^2}{1-\alpha} = \frac{0.01 \cdot 0.046^2}{1-0.046} = 2.198 \cdot 10^{-5}$$

2. The transport numbers of HCl at infinite dilution are estimated to be $t^+ = 0.821$ and $t^- = 0.179$. The molar conductivity 426.16 S cm²/mol. Calculate the ionic conductivities and mobilities of the hydrogen and chloride ions.

$$\lambda_+ = 0.821 \cdot 426.16 \frac{\text{S cm}^2}{\text{mol}} = 349.9 \frac{\text{S cm}^2}{\text{mol}}$$

$$\lambda_- = 0.179 \cdot 426.16 \frac{\text{S cm}^2}{\text{mol}} = 76.3 \frac{\text{S cm}^2}{\text{mol}}$$

$$u_+ = \lambda_+/F = 349.9/96485 = 3.63 \times 10^{-3} \frac{\text{cm}^2}{\text{S} \cdot \text{V}}$$

$$u_- = 7.91 \times 10^{-4} \frac{\text{cm}^2}{\text{V} \cdot \text{S}}$$

3. A solution of LiCl at a concentration of 0.01 M is contained in a tube with cross-sectional area of 5 cm². Calculate the speeds of the Li⁺ and Cl⁻ ions if a current of 1 A is passed. Use ionic conductivities $\Lambda_0(\text{Li}^+) = 38.6 \text{ S cm}^2/\text{mol}$ and $\Lambda_0(\text{Cl}^-) = 76.4 \text{ S cm}^2/\text{mol}$.

$$\Lambda_0 = (38.6 + 76.4) \frac{\text{S cm}^2}{\text{mol}} = 115 \frac{\text{S cm}^2}{\text{mol}}, \quad \kappa = \Lambda_0 \cdot c = 115.0 \times 10^{-5} \frac{\text{S}}{\text{cm}}$$

$$G = \kappa \cdot \frac{A}{l} = \frac{I}{\Delta V} \Rightarrow \frac{\Delta V}{l} = \frac{I}{A \cdot \kappa} = \frac{1 \text{ A}}{5 \text{ cm}^2 \cdot 115.0 \cdot 10^{-5} \frac{\text{S}}{\text{cm}}} = 173.9 \frac{\text{V}}{\text{cm}}$$

$$u(\text{Li}^+) = \Lambda_0(\text{Li}^+)/F = 4.00 \times 10^{-4} \frac{\text{cm}^2}{\text{V} \cdot \text{S}}; \quad u(\text{Cl}^-) = \Lambda_0(\text{Cl}^-)/F = 7.92 \times 10^{-4} \frac{\text{cm}^2}{\text{V} \cdot \text{S}}$$

$$v(\text{Li}^+) = u(\text{Li}^+) \cdot \frac{\Delta V}{l} = 4.00 \times 10^{-4} \frac{\text{cm}^2}{\text{V} \cdot \text{S}} \cdot 173.9 \frac{\text{V}}{\text{cm}} = 0.070 \frac{\text{cm}}{\text{S}}$$

$$v(\text{Cl}^-) = u(\text{Cl}^-) \cdot \frac{\Delta V}{l} = 0.138 \frac{\text{cm}}{\text{S}}$$